BIRDS OF 'ATA AND LATE, AND ADDITIONAL NOTES ON THE AVIFAUNA OF NIUAFO'OU, KINGDOM OF TONGA *

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ABSTRACT

The islands of 'Ata and Late have been visited for the first time by an ornithologist. The islands are important breeding sites for seabirds. *Fregata ariel* and *F. minor* nest on both islands. 'Ata is the only Tongan island where *Sula dactylatra* breeds. It also has a large population of *Puffinus pacificus*, and a few *Procelsterna cerulea* have been seen. Among forest birds, the abundance of *Gallicolumba stairii* on Late was most conspicuous. Among the rare and locally distributed birds of Tonga, the whistler *Pachycephala melanops* and the fruit-dove *Ptilinopus perousii* were found to be common. The lory *Vini australis* was seen only occasionally. On Niuafo'ou, Jungle Mynas *Acridotheres fuscus* have increased dramatically since 1984; the species is now considered a pest on fruit crops. The megapode *Megapodius pritchardii* seems to be threatened not only by the collecting of eggs, but also by development plans of the Tongan government. Numbers are probably higher than estimated in 1984. The avifaunal history of the three islands is discussed in the light of recent palaeontological findings. Human activities probably had a significant influence on the present-day composition of fauna and flora. The avifauna of Late probably comes close to that of a young volcanic island in pre-human times and so offers great chances for comparative studies in avian ecology. Finally, conservation issues are discussed, stressing the importance of remote Tongan islands for a regional concept of bird preservation.

INTRODUCTION

Although our knowledge of bird faunas on islands in the tropical Pacific is increasing, mainly due to intensified efforts of conservation agencies, many remote islands have not been visited by ornithologists. Between 1922 and 1928, the Whitney South Seas Expedition (WSSE) visited most of the islands of this region and collected numerous specimens. The results are discussed in many taxonomic publications (see reference list). Biological data, however, were not collected and most visits were too short to allow comprehensive accounts of the islands' avifaunas. Hence, because of the inadequate sampling of the WSSE, it is no surprise that some recent surveys revealed higher species numbers (Watling 1982, 1985).

The avifauna of the Tongan archipelago is one of the most neglected among the island groups in the Pacific. The Brehm Fund South Seas Expedition is currently surveying a number of islands in the Kingdom of Tonga to assess the status and prospects of those species which have disappeared from most parts of their ranges owing to human activities, and to identify potential reserve islands for endangered species. Work during the project, however, also yields biological data about most of the species and will probably add greatly to the current knowledge about the distribution of Tongan birds.

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As part of this project, I visited the Tongan islands of Niuafo'ou, Late, and 'Ata early in 1990. I had visited Niuafo'ou in 1984, but the expeditions to Late and 'Ata were mainly to get a first impression of these islands and to plan future surveys. Nevertheless, it seems justified to publish the recordings because much new ground has been broken.

DESCRIPTIONS OF THE ISLANDS

'Ata

'Ata is the southernmost islands in the Kingdom of Tonga, lying about 160 km SSW of Tongatapu. The island is composed of a 'plateau' bordered by two mountains in the west and two lower peaks in the east, almost completely surrounded by steep cliffs between 60 and 100 m high (see Figure 1). The total land area is approx. 1.5 km^2.' Ata is probably the oldest island in the western chain of volcanic islands in Tonga; no volcanic activity has ever been reported historically.

The 'plateau' is heavily forested. Figs (*Ficus* spp.) are abundant. Pawpaws are locally common, 'ifi (*Inocarpus edulis*) and coconuts are few and other formerly cultivated plants are rare and probably disappearing.

Vegetation on the cliffs is rather sparse, mainly found in less steep areas, where a variety of common Pacific islands pioneer plants is growing. Some slopes on the north have a dense, low thicket of *Wedelia biflora*, while the only site of access to the 'plateau' has even stands of low trees, with puko (*Pisonia grandis*), fau (*Hibiscus tiliaceus*), and toa (*Casuarina litorea*) being the most common species.

'Ata was inhabited until the middle of the 19th century. According to Anderson (1978), the island was settled late in Tongan history and the human population was small and isolated from the rest of Tonga. His survey revealed signs of habitation and agriculture in most parts of the 'plateau' and around the camp site (see Figure 1).

The Polynesian rat (*Rattus exulans*) is the only mammal on the island. Three species of skink occur, *Emoia cyanura*, *E. pheonura*, and *Cryptoblepharus eximius*, but no geckos have been found.

Late

Late is an almost circular volcanic island of about 18.5 km^2. Major topographical features are given in Figure 1, as are places mentioned in this report. Minor volcanic activity was reported last in 1965. The island is 1-2 million years old (R. Gatliff, pers. comm.)

The vegetation of Late has been described in detail by Sykes (1981), but the plant communities have not been mapped. Those of the lower parts of the island can be roughly divided into broad-leafed (cf. Sykes 1981) and toa forests. The former has a closed canopy of typical Tongan forest trees and is wet and dark with a conspicuous abundance of bird-nest ferns (*Asplenium* sp.) on the ground. Solitary 'ovava (*Ficus obliqua*) trees tower in abundance above the canopy. Toa forest grows on all younger lava flows, where water quickly percolates into the porous ground. Pioneer species are scattered throughout, forming small groves in more humid places. Transitional stages between the pioneering toa community and broad-

leafed forest occur, but to an extent which suggests a fast turnover as soon as enough soil is accumulated to maintain a high humidity.

A few kava (*Piper methysticum*) plantations have been established in recent years, mainly by people from the island of Ovaka in the Vava'u group. The most extensive area is around the landing site called Lolomilo. Associated disturbed areas are dominated by dense stands of loupata (*Macaranga harveyana*), manonu (*Tarenna sambucina*), and pawpaws. In addition, various crop plants have been introduced to provide food for the plantation workers. Small working parties usually spend a few days only on the island, and they do not move far from the plantation areas. In 1976 and 1977, however, a group of less than 10 people spent one year on the island.

Late was inhabited until about the middle of the 19th century. I could not find out anything about the initial settlement on the island, the exact location of the village(s), and the number of people who had lived there. The descendants of the Late people are now living on Hunga in the Vava'u group.

In contrast to its rich avifauna, only two species of mammal (the Polynesian rat and the fruit-bat *Pteropus tonganus*) and four species of reptile (the skinks *Emoia cyanura*, *E. pheonura*, and *Cryptoblepharus boutonii*, and the gecko *Gehyra oceanica*) have been seen. The bat *Emballonura semicaudata* could have been overlooked, but other widespread geckos and the skink *Lipinia noctua* may not be present because I searched for them intensively under the bark of dead trees.

Niuafo'ou

Niuafo'ou is probably the youngest island in the Kingdom of Tonga, less than 1 million years old. It is an almost circular island of about 55 km^2, of which about 18 km^2 are covered by the central crater lakes. The highest point of the ridge surrounding the crater is 205 m a.s.l. While the outer slopes are covered by plantations and large lava fields, the inner slopes and the islands in the large lake (Vai Lahi) have dense forest. Plantations are dominated by coconut palms, often with regrowing forest trees of considerable height; 700 - 1000 people live on the island.

A more detailed description of Niuafo'ou is given in Rinke (1986b), and only a few additions are made here. Motu Si'i, the smallest island within Vai Lahi with an area of about 0.01 km^2, has a dense toa forest with broad-leafed forest trees growing abundantly in the understorey, a few of which rise into the canopy. The island is less than 20 m at its highest point. Motu Molemole (about 0.26 km^2) is an old volcanic crater, the ridge being up to 55 m high, with a small lake in the east. This island and Motu Lahi (the largest of the three islands) have a very similar vegetation of dense and humid broad-leafed forest, although the eastern sides are drier and in parts dominated by large toa trees.

Access to the crater by vehicle is difficult, and boats are rarely taken there. Hence the islands are relatively undisturbed. A few coconuts grow on each of them; and the two larger islands have small herds of goats, which were put there about 5 years ago. The herds are very small, and I saw no signs of destruction of plants.

Other domestic animals roam freely in many parts of Niuafo′ou but not on the islands of Vai Lahi. Cats and pigs can be found almost everywhere, and the shores of the lakes, and especially the land bridge between the lakes, are heavily grazed by horses and cattle.

Other mammals on the island are the fruit-bat *Pteropus tonganus*, which has colonies on all the islands in the crater lake, the bat *Emballonura semicaudata*, and the Polynesian rat, which is also on the islands of Vai Lahi. No signs of roof rats (*Rattus rattus*) have been found (contrary to Todd 1983): the rat living under the roofs of houses in Niuafo′ou is the Polynesian rat.

The skink fauna consists of the large black terrestrial *Emoia nigra*, a medium-sized arboreal species (*E. murphyi*), *E. cyanura*, *E. pheonura*, the partly nocturnal *Lipinia noctua*, and a black variety of the widespread coastal *Cryptoblepharus eximius*. Two geckos, *Gehyra oceanica* and *Lepidodactylus lugubris*, have been found, but other species may occur.

METHODS

General remarks

In addition to my own observations, I include in the species accounts records of forest birds on ′Ata and Late made during the WSSE (Beck, unpubl.; Correia, unpubl.) and by Anderson (1978) on ′Ata. The occurrence of seabirds in Tonga has been thoroughly reviewed by Jenkins (1973, 1979, 1980, 1982), and so I do not include in this paper the seabird records of the WSSE and Anderson.

Another source of information was conversation with Tongans, especially people who had worked on Late and about the megapode, which receives considerable attention from the people of Niuafo′ou owing to its unique breeding behaviour.

I do not give Tongan bird names, which are listed in most publications. The Jungle Mynah had no name on Niuafo′ou at the time of my 1984 visit. It is now usually called Ngutu′enga ("yellowbill"), sometimes Va′e′enga ("yellowfoot"). People from the islands of the Vava′u group had no name for the ground-dove. The name Tu, assigned to this species by Watling (1982), may originally have come from the Ha′apai group, where ground-doves are on a few islands.

While names of land birds are generally unmistakable, seabird names are somewhat confusing. Often one name refers to different species of a genus (both *Anous* species are called Ngongo, both frigatebirds Helekosi, and all *Sterna* species ′Eki′aki). All three species of booby are called Ngutulei and their downy juveniles are called Kapatoka on some islands.

′Ata

I visited the island from 5 to 8 April 1990. One day was spent in the 'plateau' forest, where I walked around as indicated in Figure 1 for about four hours. The remaining two days, I surveyed seabirds on the slopes between the northern tip of the island and the campsite. Unfortunately, much time had to be spent carrying equipment and provisions between the landing place and the campsite.

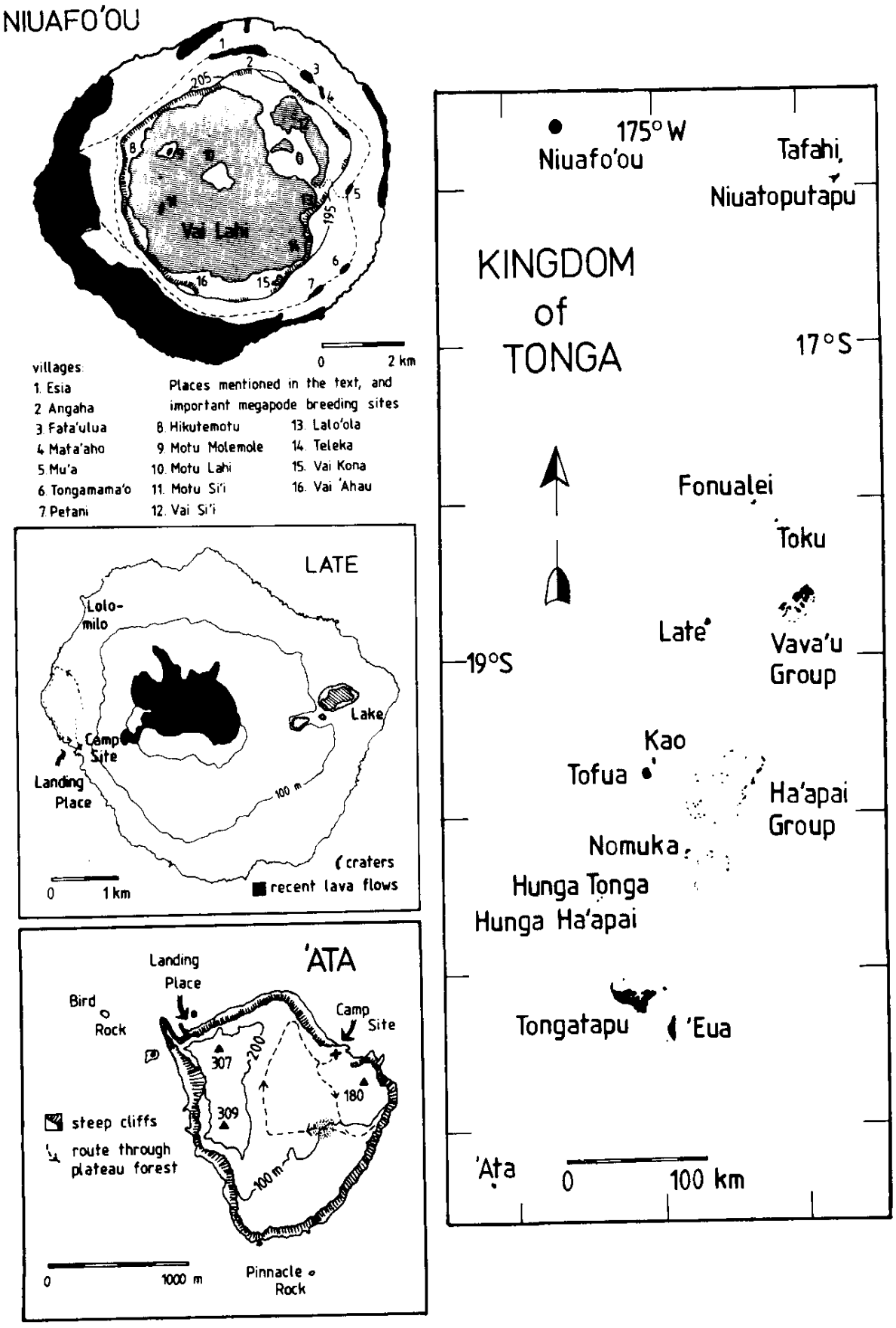

FIGURE 1 — The Kingdom of Tonga, including more detailed maps of Niuafo'ou, Late and 'Ata. Stippled area on 'Ata: approximate location of former human habitation

Late

I stayed on Late between 15 and 21 March 1990. Owing to rough seas, the most frequented landing site at Lolomilo could not be used. This site is reported to have easy access to the lake in the east and the volcanic cone. So, most of the time was spent in an area about 1 km around our campsite south of the western tip of the island. The site was in wet broad-leafed forest interspersed with some secondary vegetation where talo had been planted a few years before. The bay around the landing site with its forested slopes was visited at least once every day.

Four mist-nets (length 18 m, height 3 m, 0.5 m above the ground) were set about 100 m from the campsite. Working hours and results are given in Table 1.

TABLE 1 — Species and numbers of mist-netted birds on 5 days on Late

Days	1	2	3	4	5	Total
Hours	9	11	2.5	10	10	42.5
Gallicolumba stairii	26	19	3	10	6	64
Aplonis tabuensis	24	6	1	2	5	38
Pachycephala melanops	4	3	-	6	1	14
Foulehaio carunculata	-	1	3	1	-	5
Halcyon chloris	-	1	-	-	-	1
Ptilinopus porphyraceus	-	-	-	-	1	1
Sula sula	-	1	-	-	-	1
Anous minutus	-	-	1	-	-	1

Niuafo' ou

I visited the island from 8 to 22 February 1990. I spent four days in the village of Petani in the south of the island, from where I made excursions along the main road to the west (3 - 4 km), occasionally detouring towards the coast, and to the shallow southern shores of Vai Lahi. The following four nights, I spent on Motu Lahi, from where I rowed to the other islands, to Hikutemotu, and to some parts of the shore inaccessible by walking (Teleka and Lalo' ola).

Two further nights I spent at the shore of Vai Lahi very close to Vai Kona, where I recorded the calls of the megapode. The remaining days, I stayed in Esia, from where I walked several times to the coast, and once to Futu crossing extensive lava fields. I set two small mist-nets (length 6 m, height 3 m, 1 m above the ground) for two days in a garden at the edge of this village.

Specific remarks on the species of Niuafo' ou are included only when these given additional information to my 1986 paper.

SPECIES ACCOUNTS

WEDGE-TAILED SHEARWATER *Puffinus pacificus*

'Ata: Probably the most common seabird on the island. Burrows, a few occupied by chicks with well-developed primaries, were abundant around the island where the slopes are not too steep, especially at the edge of the plateau forest. The total number on the island was estimated at more than 20 000, from the number of adults present in a nesting area (edge of the plateau forest above the campsite), and at more than 50 000 from the number of burrows (provided that every burrow is occupied at one season).

While spending a night in a nesting area, I saw birds digging burrows and in courtship behaviour. The 'concert' of whining sounds opened about two hours before dawn. Birds sang only close to each other – the song may be part of a departing ceremony between mated pairs.

Two smaller petrels or shearwaters with a black-and-white plumage, possibly Audubon's Shearwater (*Puffinus lherminieri*), were seen flying from the island to the sea in the early morning.

Late: Kava growers on Late told me that Wedge-tailed Shearwaters breed on the island. I did not see or hear any, but since I did not visit the higher parts of the island, I did not discover the probable nesting areas.

Niuafo'ou: Tongans decoy the birds to the coast by imitating their 'songs' and then kill them for food with long sticks. The numbers of shearwaters slain during breeding season from October to March indicate a large breeding population. I found signs, mostly feathers, of these activities in great abundance at many places around the coast. One evening, after sunset, I attended the hunting of shearwaters, but as the breeding season was almost finished at the time of my visit, only one shearwater appeared.

HERALD PETREL *Pterodroma heraldica*

'Ata: A single, fully-feathered juvenile was found on the ground of the plateau forest (weight 610 g; wing length 30.0 cm). This bird is known as Lafu.

Late: A seabird called Lafu is reported to be on the island. It probably refers to this species, the Black-winged Petrel (*Pterodroma nigripennis*) or Aubudon's Shearwater.

Niuafo'ou: The names Taiseni and Lafu certainly refer to *Pterodroma* species. Niuafo'ou people reported that birds are occasionally found in caves or burrows in the mountains. These are almost certainly petrels or shearwaters. A large and heavy chick, still in downy plumage, was found in a cave above Esia village. It possibly was a Herald Petrel.

High densities of burrows were found in many parts of the islands in the crater lake, especially at slopes below the ridges, mostly in the root systems of large *Casuarina* trees. I found no birds, but noticed feathers and a smell of fish in some of the burrows. While spending three nights on Motu Lahi, I heard petrel or shearwater calls.

In general, the distribution of petrels and shearwaters in Tonga is poorly understood and the number of species breeding in the islands is not yet known.

Their diversity in Tonga may be greater than indicated by former reports because Tonga extends from subtropical ' Ata in the south to hot and humid Niuafo' ou 700 km to the north.

WHITE-TAILED TROPICBIRD *Phaethon lepturus*

' Ata: Several were seen circling the cliffs above the landing site.

Late: Abundant near the slopes around the landing site and high above the island. One was found sitting on an egg.

Niuafo' ou: Two chicks of about 250 g were found in hollows on the ground below the northwestern ridge on Motu Lahi. The relatively exposed position of these nest sites is in strong contrast to the inaccessibility of most White-tailed Tropicbird nests on islands with human populations.

RED-TAILED TROPICBIRD *Phaethon rubricauda*

' Ata: Several were seen flying around the northern coast; one was resting in a rock cave, and another sitting on an egg under the dense *Wedelia* thicket, both on the northern slopes.

MASKED BOOBY *Sula dactylatra*

' Ata: Moderately common around the island, where roosting birds were seen on exposed flat areas covered with very low vegetation. Rarest of the three booby species on ' Ata, the total population certainly does not exceed 1000 birds. I saw one half-grown chick at the edge of the plateau forest above the eastern cliffs and a few in juvenile plumage.

Late: One probably sighted during the landing procedure, but I did not see the species thereafter. Jenkins (1973) recorded a flock of about 30 in Vava' u waters.

RED-FOOTED BOOBY *Sula sula*

' Ata: The commonest booby on the island. Almost all trees on the slopes and many on the edge of the plateau forest were used as roosts. The total population was estimated at about 10 000. White-phase birds far outnumbered those of the brown phase. No active nests were recorded, but birds in juvenile plumage were common.

Late: Abundant around the landing site and throughout the broad-leafed forest. Both colour variants were present, as well as many juveniles, but nesting activities were not noted.

BROWN BOOBY *Sula leucogaster*

' Ata: Common on the cliffs around the island and on the exposed offshore rocks. Numbers were between those of the other two booby species. Birds in juvenile plumage were seen, but no active nests were found.

Late: Common around the coast where *Casuarina* forest approaches the cliffs. North of the western tip of the island, some Brown Boobies were sitting on slight depressions 'decorated' with a few blades of grass and leaves, in low grass above the cliffs. None of these nests contained eggs.

GREATER and LESSER FRIGATEBIRDS *Fregata minor and F. ariel*

' Ata: Both species are common, but *minor* more so than *ariel*. No males of *ariel* were seen, but females and subadults were noted every day. One frigatebird was sitting on a nest in a large tree on the plateau; only its tail feathers were visible. A male *minor* displayed with an inflated throat pouch.

Late: Both species are common, but again *minor* seems to be more numerous. Breeding of both species was indicated by the presence of juveniles in first-stage and second-stage plumages (cf. Harrison 1983), by two observations of unidentified females carrying nesting material, and by displaying males. Only one out of more than 30 sightings of males in flight with inflated throat pouches was of *ariel.*

PACIFIC REEF-HERON *Egretta sacra*

Late: Not observed, but has been seen according to my Tongan informants.

Niuafo'ou: Common around the lakes within the crater. My 1984 estimate of about 30 birds distributed around the lakes proved to be a substantial underestimate. With better accessibility to all shores of Vai Lahi by outrigger canoe, I found at least five times that number.

GREY DUCK *Anas superciliosa*

Late: Not seen, but it is said to be abundant at the lake.

Niuafo'ou: Moderately common, but hard to see because of its shyness. Halfgrown chicks were seen on three occasions. A few were seen at the small lake on Motu Molemole. According to Niuafo'ou people, the population was about 10 times higher before the introduction of the cichlid *Oreochromis mossambica* into the lakes in about 1975. At present, there is a mass mortality of cichlids, which have probably overexploited the algae and invertebrates of the lake. This food shortage could also have adverse effects on the numbers of the ducks because cichlids and ducks were probably competing for very similar resources.

SWAMP HARRIER *Circus approximans*

'Ata: Seen and collected by the WSSE, but not seen by any member of the expedition during my stay.

NIUAFO'OU MEGAPODE *Megapodius pritchardii*

Niuafo'ou: The megapode is Tonga's only single-island endemic bird. A detailed report is outside the scope of this paper and will be published separately (Rinke, in prep.). Brief details additional to those presented earlier (Rinke 1986b) are given here.

Megapodes were seen on Motu Lahi and at the lake close to Vai Kona. They were heard many times at these locations, and in addition, on Motu Molemole, at Hikutemotu, and at the southwestern shore of the lake. Calls were heard mostly in the early morning and occasionally during the rest of the day and at night. These calls are actually duets between mated pairs, where the male starts, the female answers very shortly, and the male terminates the duet.

In relation to the frequency of calls heard at Vai Kona and on Motu Lahi (the only places where I spent nights in megapode habitat), my 1984 remarks about the number of megapodes (about 400) seem to be gross underestimates. Todd (1983) estimated the population at about 820 adults in 500 ha of habitat where the species was found during his studies (1976 and 1979) and gave a carrying capacity of 2500 for about 1500 ha of suitable habitat. My rough estimates resulted in similar numbers.

I visited most of the nest sites that Todd (1983) listed, and I gained information about all locations through interviews with Niuafo'ou people who regularly dig for megapode eggs. All sites, except one on the south-western coast, are within the crater. At present, no nest sites are known from the steep western and northern shores of Vai Lahi, but these places are seldom visited. About one-third of the sites that Todd (1983) studied have been abandoned.

In contrast to the results reported from 1984, eggs and chicks were in almost all sites I visited, even in those which were easily accessible. This may have resulted from an accident in 1989, when a man digging for eggs was buried alive under sliding soil. Since then, collecting activity has been less on the whole island.

Measurements of 8 hatchlings: weight 43 - 51 g, mean 48.5 g; wing length 81 - 90 mm, mean 85.4 mm. I reported that hatchlings could fly only weakly (Rinke 1986), but after a period of about three days (about the same time between hatching and reaching the surface of the nest site) they can fly for long distances and land on branches in high trees.

The Tongan government is currently debating plans to build a crude oil depot in one of the smaller crater lakes. Associated activity will destroy most of the megapode habitat and will almost certainly lead to the species' disappearance.

RED JUNGLE-FOWL *Gallus gallus*

'Ata: Occasionally seen and heard. One hen was sitting on an empty nest, and two half-grown chicks were seen.

BANDED RAIL *Gallirallus philippensis*

'Ata: Anderson (1978, p. 2) reported a 'probable rail' from the island. Although I once possibly heard an alarm call of the Banded Rail, none was seen.

Late: A single call was heard in *Casuarina* forest. The species was not seen or heard in broad-leafed forest. My Tongan informants stated that the birds are occasionally seen around the main kava plantations at Lolomilo.

Niuafo'ou: Common; but less abundant on the islands of the crater lake. One newly hatched young, accompanied by an adult, and a half-grown chick with two adults were seen.

SPOTLESS CRAKE *Porzana tabuensis*

Late: Not seen during my visit, but reported to be present by my Tongan informants.

The WSSE saw a couple and collected one specimen from the island (Amadon 1942a).

Niuafo'ou: Seen twice very briefly in the forest on Motu Lahi.

PURPLE SWAMPHEN *Porphyrio porphyrio*

Late: Not seen, but according to my Tongan informants, it is present, especially close to the lake.

Niuafo'ou: Seen occasionally on the flat southern shore of Vai Lahi.

PACIFIC GOLDEN PLOVER *Pluvialis fulva*

Niuafo'ou: Abundant.

WANDERING TATTLER *Heteroscelus incanus*

'Ata: Seen twice on rocks close to the sea.

Late: Seen once.

Niuafo'ou: Uncommon, only at the lakes.

BROWN NODDY *Anous stolidus*

'Ata: Abundant on steep cliffs, in large numbers on the isolated rocks close to the island. Flocks of several hundred roosted on big rocks close to the shore. The population certainly exceeds 10 000. A few fledglings were seen, indicating the end of the breeding season.

Late: Abundant around the landing site. Many fledged juveniles were sitting on rocks and in low bushes.

Niuafo'ou: Seen in low numbers around the coast. According to Niuafo'ou people, it breeds in a few places with steep cliffs around the coast.

BLACK NODDY *Anous minutus*

'Ata: Abundant in trees, especially in fa (*Pandanus tectorius*) and puko (*Pisonia grandis*) on the slopes around the island. Almost all were roosting in trees. Possibly more numerous than the Brown Noddy. Many fledged juveniles were seen.

Late: Very abundant, outnumbering *A. stolidus* by about 5 : 1, at least around the landing site. Adults and fledged juveniles were roosting in great numbers in large trees, especially in puko. Measurements of the mist-netted bird: weight 115 g, wing length 23.5 cm.

BLUE-GREY NODDY *Procelsterna cerulea*

'Ata: A few roosting (and breeding?) on sparsely overgrown projections in the cliffs above the landing site.

FAIRY TERN *Gygis alba*

'Ata: Common on trees at the slopes above the campsite and on the plateau. Certainly breeds on the island.

Late: Common.

Niuafo'ou: Common.

TERNS *Sterna* sp.

Niuafo'ou: Single unidentified whitish terns with black caps were seen on the coast several times. They were certainly not *S. bergii.*

FRIENDLY GROUND-DOVE *Gallicolumba stairii*

Late: The most common bird in the undergrowth and on the ground of broad-leafed forest (see Table 1); also in the transitional zone between broad-leafed and *Casuarina* forests. The density of this species is remarkable, sometimes up to five being within a radius of about 10 m around me. They fly when approached to about 10 m, but single birds could be approached to about 5 m. Although food is mainly taken on the ground (e.g. fallen fruits of 'ovava), a few were seen feeding in manonu and one in the crown of a large 'ovava.

Among the mist-nested ground-doves, many showed typical juvenile plumage characters: no or few purple feathers on the shoulder, less extended breast shield, less clearly set off from the dark lower breast colour than in adults, lack of greenish lustre on the hindneck, and pale bluish-grey feet and legs (instead of the coral red of adults). A total of 27 were measured: weight mean 130.3, range 85-180 g; wing length mean 15.0, range 13.7-16.6 cm. Of these 20 were in adult plumage: weight 110-180 g, wing length 14.6 - 16.6 cm.

Reported to be common by the WSSE, and one specimen was collected (Amadon 1943).

MANY-COLOURED FRUIT-DOVE *Ptilinopus perousii*

Late: Heard commonly, but seen only a few times. All records were from large ' ovava trees extending beyond the forest canopy.

A female and her egg were collected by the WSSE (cf. Ripley & Birckhead 1942).

PURPLE-CROWNED FRUIT-DOVE *Ptilinopus porphyraceus*

Late: Common in broad-leafed and *Casuarina* forests but rarely seen. Measurements of a mist-netted bird: weight 131 g, wing length 13.1 cm.

Not mentioned in the journals of the WSSE but collected on the island (Ripley & Birckhead 1942).

Niuafo' ou: In contrast to my 1984 visit, I did not see or hear this species close to the villages, where it may have suffered from the increase in myna numbers. Frequently heard in the forest around the lakes but most common in pockets of bush throughout the lava flows, where it was seen feeding on the fruits of ' ovava, masi' ata (*Ficus tinctoria* or *F. scabra*), volovalo (*Premna taitensis*), and ngahu (*Scaevola taccada*). Some were in all-green juvenile plumage.

PACIFIC PIGEON *Ducula pacifica*

' Ata: Only in the plateau forest, where heard many times. Recorded by Anderson (1978), and collected by the WSSE (Amadon 1943).

Late: Probably common, as its calls were heard throughout the broad-leafed forest. Occasionally seen flying over the landing site and roosting in *Casuarina* trees. Reported to be very rare by the WSSE, but collected (Amadon 1943).

Niuafo' ou: Very common and not as shy as on ' Eua (inhabited) or on Late and ' Ata (both uninhabited); also on Motu Lahi and Motu Molemole in the crater lake. It is occasionally killed with sling-shots.

BLUE-CROWNED LORIKEET *Vini australis*

Late: Rarely heard, and only two birds were seen feeding on flowers in a high forest tree. Mostly recorded from above the forest canopy. Not very common, perhaps because flowering trees are scarce.

Seen and collected by the WSSE (Amadon 1942b).

Niuafo' ou: Abundant; also on the islands in the crater lake. The two smaller islands seem to be roosting and breeding sites because they lack flowering trees to provide food (*Casuarina* dominates). During two 3 km walks through a mixed plantation area dominated by coconuts west of Petani village, I heard calls of lories continuously. They fly when approached to

about 10 m, but feeding birds could be approached as close as 1.5 m.

I saw them feeding at unripe mangoes and at the flowers of 'iku' ikuma (*Stachyrtarpheta urticifolia*), a woody weed up to 2 m high, both probably taken because of food shortage after a hurricane that had passed the island one week before my visit.

According to local people, many nestlings are found in December, mostly on Motu Lahi. A lory in juvenile plumage was kept by a family. Such pets are usually tied by one foot, and the children play with them until they die.

LONG-TAILED CUCKOO *Eudynamys taitensis*

Niuafo'ou: One seen on the forested plateau above the northern shore of the crater lake.

BARN OWL *Tyto alba*

'Ata: One was scared from a crevice at the foot of steep cliffs above the campsite.

Seen by the WSSE, and recorded by Anderson (1978).

Late: Although this widespread species is probably on the island, my local informants did not confirm its existence. Not seen during my visit.

Niuafo'ou: Occasionally seen; also on the two large islands in the crater lake. One was seen carrying a rat in daytime.

WHITE-RUMPED SWIFTLET *Aerodramus spodiopygius*

Late: Common around the cliffs and above the broad-leafed forest, also in *Casuarina* forest.

Seen by the WSSE.

Niuafo'ou: Common, but not seen above the bare lava fields. One was mist-netted, even though the species is able to locate the nets (as I experienced on 'Eua and Tongatapu).

WHITE-COLLARED KINGFISHER *Halcyon chloris*

Late: Occasionally seen in every habitat. Measurements of a mist-netted female: weight 67 g, wing length 10.0 cm.

POLYNESIAN STARLING *Aplonis tabuensis*

'Ata: Very common. Seen and heard everywhere in the plateau forest. A few were seen in low vegetation on the slopes close to the campsite. The song seemed to be louder than on other Tongan islands.

Seen and collected by the WSSE (Mayr 1942). Anderson (1978) mentioned a passerine from the island; it was certainly this species.

Late: Probably the most common passerine in broad-leafed forest on the island (at least the most common passerine in the lower zone, cf. Table 1), but also in toa forest. Fruits of manonu and 'ovava were recorded as food. Measurements of 13 mist-netted birds: weight mean 60 g (range 54-64 g), wing length mean 11.3 cm (range 10.7-11.7 cm). Two mist-netted birds were recently fledged juveniles.

Collected by the WSSE (Mayr 1942).

Niuafo'ou: Common everywhere, but less abundant than mynas and bulbuls. Also on the islands in the crater lake, where a fledgling was found on Motu Si'i. In addition to my 1984 notes, pawpaws and breadfruits have

been recorded as food plants, and it was seen feeding at opened coconuts on the ground (a behaviour not observed on other Tongan islands).

EUROPEAN STARLING *Sturnus vulgaris*

'Ata: The WSSE saw flocks of this species, but I did not see any. European Starlings probably colonised the island by natural dispersal from New Zealand via the Kermadec Islands. At the time of their arrival, open habitats (plantations) may have helped them colonise successfully. At present, however, no such habitat exists, and the species must have become extinct during the period of forest recovery. There is a very slight possibility that European Starlings are around the two 300 m peaks of the island, which were covered by grasses during Anderson's visit (Anderson 1978).

JUNGLE MYNA *Acridotheres fuscus*

Niuafo'ou: Very common in villages and plantation areas, but small flocks were seen everywhere except on the islands in the crater lake and on the lava fields. According to Niuafo'ou people, the species arrived between 1980 and 1982, though it is not known how it arrived. There has been a dramatic increase in numbers since my 1984 visit, and the bird is now considered a major agricultural pest on the island. It feeds mainly on fruit crops, but has also been seen taking fruits from many native plant species. It is reported to prey on eggs and small nestlings of bulbuls. Many fledglings were seen during my visit, and these are, next to bulbuls, the main target of boys with sling-shots.

RED-VENTED BULBUL *Pycnonotus cafer*

Niuafo'ou: By far the most common bird in all habitats on the island; also on the islands in the crater lake. I caught 35 bulbuls in the two mist-nets. Large numbers gather quickly at any kind of food, even in remote places such as Motu Lahi. Many fledglings were present. They fly when approached to 5-7 m, and boys often kill them with sling-shots and even with sticks. The red belly feathers of the adults are sometimes plucked and used to decorate mats, in the same way as the red feathers of parrots are used elsewhere.

Bulbuls may have been introduced earlier than in the 1950s, as reported previously (Rinke 1986b). The WSSE visited Niuafo'ou on 17 and 18 August 1925 and neither mentioned nor collected bulbuls. Those few people from Niuafo'ou who made any comments about this matter all dated the arrival of the bulbul as the early 1930s and said that the birds were brought by a yacht.

POLYNESIAN TRILLER *Lalage maculosa*

Late: Seen several times in *Casuarina* forest, including one fledged juvenile being fed by an adult. Not recorded under the canopy of broad-leafed forest but was seen once in a large *Ficus obliqua* which emerged above the forest canopy. Collected by the WSSE (Mayr & Ripley 1941).

WATTLED HONEYEATER *Foulehaio carunculata*

Late: Common in broad-leafed as well as in *Casuarina* forest, but among passerines only third in abundance in the lower zone (cf. Table 1). Measurements: weight 28 (juvenile), 38, 39, and 37 g (males); wing length 9.1 (juv), 10.6, 10.5, and 10.4 cm (males).

Reported to be abundant by the WSSE; also collected (Mayr 1932a).

TONGAN WHISTLER *Pachycephala melanops*

Late: Only in broad-leafed forest; common. Usually seen in pairs. The songs of the males are very conspicuous and highly variable. Measurements of mist-netted birds: weight 30 and 33 g, wing length 9.7 and 9.6 cm (juv.); 33, 36, and 38 g, 9.7 9.5, and 9.6 cm (females); mean 35.6, range 32-39 g, mean 10.1, range 9.9-10.3 cm (8 males).

Not mentioned in the journals, but collected from the island by the WSSE (Mayr 1932b).

DISCUSSION

"Today's problems are so urgent that any 'esoteric' research not directly applicable to conservation is an unaffordable luxury" (L. Tangley, *BioScience* 38/7, p. 448). The main purpose of the Brehm Fund South Seas Expedition is to study rare and endangered birds on tropical Pacific islands and to identify suitable reserve islands. Therefore, the discussion is somewhat biased according to Tangley's statement expressed at the workshop "Research Priorities in Conservation Biology".

The composition of the avifaunas – a historical reflection

The three islands dealt with in this paper differ considerably in the degree of human disturbance to their environment.

' Ata had a human population for a few hundred years until the middle of the 19th century. During this period, most of the 'plateau' forest was used to grow food crops. Birds and their eggs, especially those of the abundant seabirds, were an easily obtainable food source in the initial phase of settlement. Bones of a gallinule, a parrot, and another species of pigeon (or dove) besides those of the extant species have been found in kitchen middens (Anderson 1978). The cultivation of the 'plateau' and hunting could have resulted in the extinction of bird species. A high rate of species turnover, however, could have also been a factor on such a small island. Good examples may be the Swamp Harrier and the European Starling, which were present during the visit of the WSSE in 1925 but were not seen during my stay.

Seabirds can probably recolonise an abandoned island much faster than landbirds, and the present assemblage of seabirds (13 species positively identified) may be close to that in prehuman times. A few species, however, such as the Polynesian Storm Petrel (*Nesofregetta fuliginosa*) or Abbott's Booby (*Papasula abbotti*) may have been lost because of human interference. The storm petrel was the most common bird found in prehistoric sites on ' Eua (Steadman, pers. comm.) and bones of Abbott's Booby have been discovered on many Pacific islands (Steadman *et al.* 1988). The Polynesian Storm Petrel has not been found breeding on any Tongan island in historical times, and there are only a few sight records in Tongan waters (Jenkins 1980). Whether this absence coincides with the presence of Polynesian rats is not known.

The number of species recorded may increase if ' Ata is visited at different times of the year, and when the two mountains have been investigated. Likely candidates are Audubon's Shearwater, as suggested by Jenkins (1980), and the Black-winged Petrel, which I recently found breeding on ' Eua.

Botanically, Late is one of the least modified islands in the Pacific (Sykes 1981). Human influence by way of agriculture during an unknown period of habitation (archaeological work has not been done on Late) must have been small, but both seabirds and landbirds could have been important foods for the Late people. Events may have taken two forms:

1. As a young volcanic islands, the avifauna of Late was always poor in species. The present extent of broad-leafed forest indicates that only very limited habitat was available for forest birds. Human influence was only slight, and the exploited species recovered fast after humans left the island in the mid-19th century. The island may have been too young for those species, or related forms, which were on most of the Polynesian islands in prehistoric times (cf. Steadman 1989a) to colonise it.

2. Alternatively, perhaps, the assemblage of landbirds on Late used to be close to that known from other Tongan islands, where, among others, there were megapodes, two species of ground-dove, and two or three fruit-pigeons (Steadman 1989a, 1989b, and pers. comm.). The size of the island, the diversity of its habitats, and its geographical location between Tonga and Fiji support this assumption. As probably happened on other Polynesian islands, humans caused the extinction of these species. The environment of Late made people more dependent on natural resources, and hence they heavily exploited the large populations of sea and forest birds.

Although seabirds may have suffered likewise, their ability to colonise remote islands makes it almost impossible to compare recent and prehistoric species assemblages. I recorded eight species on the island, all in considerable numbers. It is very likely that most of the shearwaters and petrels characteristic of the region are present. The Polynesian Storm Petrel and Abbott's Booby, however, are absent from Tonga at present, but may have bred on the island in prehistoric times (see above).

Niuafo′ou, the youngest of the three islands, differs in its history of human habitation. It was colonised during the initial phase of dispersal of humans into the region, and has been inhabited since with only short interruptions.

Its avifauna is very poor for its size, perhaps because of its remoteness; the closest land mass is the small island of Niuatoputapu, about 200 km to the east and successful colonisation must have been a rare event. Nevertheless, the equally remote islands of Niuatoputapu to the east and Futuna to the north-west have three and four species of native passerine respectively, while Niuafo′ou has one. Most surprising, however, Niuafo′ou is the only island east of Vanuatu with an extant population of megapodes.

Another confusing fact is the skink fauna of Niuafo′ou. The island has more species (6) than any other Tongan island. All the species, however, are widespread in the region, which is also the case with mammals and landbirds except the megapode.

The assemblage of seabird species breeding on Niuafo′ou is likewise enigmatic. Boobies and frigatebirds are not present, but some procellariiforms are in considerable numbers. All these are extremely vulnerable to human disturbance, and usually do not breed on inhabited islands in the tropical

Pacific. The highly diversified topography of Niuafo'ou provides suitable breeding grounds, safe from human interference, along the inner slopes of the crater, and to some extent on the islands within the lake. Hence, the nocturnal species (e.g. shearwaters and petrels) have escaped persecution, whereas the diurnal boobies and frigatebirds, though unmolested at their nests, must have been an easy target outside their breeding grounds.

But why, then, is there only one native species of passerine and why is there an endemic megapode, far from the present range of megapodes? The somewhat curious composition of the non-marine fauna of Niuafo'ou may have been caused by a disastrous volcanic eruption in the not too distant past, which might have wiped out many of the vertebrates. Highly mobile species have since recolonised the island (those landbirds, reptiles, and mammals which make up the extant non-marine fauna), while the peculiar breeding habits of the megapode saved it from extinction: its eggs, down to two metres in the ground, taking up to two months for development, might have been unaffected by the heat or by deadly gases.

Birds on pristine and human-modified islands

Birds on islands with various degrees of human interference may be compared on two levels: first the composition of the avifaunas could be compared, and, second, the ecology of a single species on differing islands could be studied. Species assemblages on islands have been compared for a long time. It is, however, a rather recent practice, initiated by paleontological studies, to consider the effects of human activities on islands when discussing the distribution of species.

The latter is a more subtle approach to identifying ecological factors which determine the occurrence and density of a species. Most studies stress the fact that the modification of an island habitat by humans has adverse affects on a native species. Yet in some cases indigenous species derive benefits from human activities.

Horticulture, which increases the all-season abundance of flowering plants, should be advantageous to nectarivorous birds, provided other factors are identical. The Blue-crowned Lorikeet is rare on uninhabited Late but very common on Niuafo'ou with its extensive coconut plantations. Horticulture also favours species of edge habitats because it produces large areas of transitional zones between cultivated and primary habitats. On Late, the Polynesian Triller is present in low numbers, whereas it is abundant on 'Eua (Rinke 1987).

The Banded Rail shows a similar pattern of abundance: it is exceedingly rare on Late, but it is common on most inhabited Tongan islands, with the highest density on Niuafo'ou (among those islands which I have visited so far). The rareness on Late is surprising because there is no terrestrial omnivorous species in the forests. Competition for food may be a factor in the relatively low densities of the lory and the triller, the former competing with the Wattled Honeyeater, the latter with frugivorous species (Polynesian Starling and small fruit-doves) and insectivorous species (Tongan Whistler), but competition has to be excluded with the Banded Rail.

The explanation may be the composition of Pacific islands avifaunas in prehistoric times. Flightless rails, counterparts of the extant Guam Rail

(*Gallirallus owstoni*) or the Lord Howe Woodhen (*Tricholimnas sylvestris*), were on all those islands which have been surveyed for subfossil remains (Steadman 1989a). The Banded Rail, however, was missing from sites clearly dating back into the pre-human period. The species, which has good dispersal ability, certainly arrived on islands of the region many times, but its successful colonisation was prevented by already well-established flightless Rails. Only after the arrival of humans, when these highly vulnerable forms became extinct, did Banded Rails gain a foothold on such islands. But even then, the species would not have been very successful, as is being clearly shown on the island of Late. Only the agricultural activity of the first human inhabitants provided an optimal habitat for the Banded Rail and allowed the species to spread as far as western Polynesia.

This again illustrates the importance of Late as a study site of an almost undisturbed indigenous fauna. Although some species might have become extinct during the period of human occupation, the extant species should at present show a similar ecology and abundance as in pre-human times. This assumption is supported by the abundance of the Friendly Ground-dove both in present-day Late and in prehistoric sites on ' Eua, where it has been the most abundant landbird species (Steadman, pers. comm.).

The importance of volcanic islands in Tonga as refuges for endangered species

The most promising approach to preserve tropical Pacific islands biota is probably the method repeatedly applied in New Zealand to rescue endangered birds. As long as mainland habitats do not provide sufficiently safe environments for native species, and the factors causing danger cannot be controlled, offshore islands in a relatively pristine state (or where such factors can be controlled successfully) are useful as refuges. Several New Zealand species have been reduced to a population on a single small island, and have since recovered through intensive management, often involving interisland transfers.

The theoretical background for the application of interisland transfers as a major concept in the efforts to preserve Pacific island species will be given elsewhere (Rinke, in prep.). The three main arguments presented are a much higher number of species on most islands and the much wider distribution of many species in pre-human times (cf. Steadman 1989a), as well as the presence of some remote islands, many of which are uninhabited and have more or less escaped alteration by human beings.

' Ata, the smallest of the islands dealt with in this account, is an important breeding site for seabirds. Masked Boobies probably do not breed on any other Tongan island, and this may prove right for the Blue-grey Noddy, too. The island is very isolated, about 160 km SSW of Tongatapu, the nearest land mass, and landing is very difficult. The Tongan government has no development plans for ' Ata, and so the birds on the island will probably not be threatened in the near future.

It remains to be discussed whether a remote and undisturbed island such as ' Ata is a suitable place on which to introduce a small flock of an endangered species of forest bird. Its small size (with only about 1 km^2 of forest) certainly cannot sustain a much larger number of species than

currently present, although bones of at least three more species have been found in archaeological sites. The presence of the feral chicken, an omnivore, excludes such terrestrial species as rails and ground-doves from further consideration. Thus, the only candidates may be a species of fruit-dove and an insectivorous passerine. The availability of 'Ata as a refuge for such species should be kept in mind for possible future conservation programmes.

Late exhibits features which could make it an outstanding place for bird conservation in the Pacific. It is a remarkable breeding site for seabirds, among which the two noddies, Red-footed Boobies and Fairy Terns may number into the tens of thousands. Its difficult access makes it remote enough (although only some 60 km west of Vava'u) to keep away potential disturbances such as increasing human activities or mammalian predators.

The area of broad-leafed forest is still increasing as a result of succession of plant communities on the younger lava flows. Even now, Late is the stronghold of the Tongan Whistler, elsewhere restricted to strips of coastal forests on the larger islands in the Vava'u group. It may have the most vigorous population of the Friendly Ground-dove in Tonga, with a density unequalled by other ground-dove populations on the Pacific islands. The island also has a strong population of the Many-coloured Fruit-dove, which has been reported from only four Tongan islands but has since disappeared from Tongatapu and has become very rare on 'Eua (pers. obs.).

The most striking character of Late's avifauna is the lack of any ground-dwelling omnivorous or insectivorous species in the island's broad-leafed forest. Late should be given high priority whenever a refuge island for an endangered species of rail of the Pacific is being sought.

Niuafo'ou received attention by Red Data Book compilers because it is the home of the Niuafo'ou Megapode (Hay 1986, Collar & Andrew 1988). Although still quite common in undisturbed forest habitats (less than 10 km^2), the species is threatened by development plans of the Tongan government. In addition, Niuafo'ou is still volcanically active, and the possibility of a disastrous eruption is a continuing threat to this last megapode population in Polynesia.

It is, therefore, highly desirable to establish the megapode on other volcanic islands of the region. Todd (1983) visited the islands of Tofua and Fonualei, but he questioned their suitability because Fonualei lacked broad-leafed forests and volcanic activity had ceased on Tofua. He did not visit Late, but I have proposed this island as a potential megapode reserve (Rinke 1986a), and it certainly complies with all requirements. Late has considerable areas of broad-leafed forest, and the niche for an omnivorous terrestrial species is not occupied. Moreover, smoke has been recorded to emerge from the central crater as late as 1965, and so the island may have suitable breeding grounds.

The search for a megapode refuge should not divert attention from Niuafo'ou, an island of great natural beauty. It has a thriving population of Blue-crowned Lorikeets and an endemic subspecies of the Polynesian Starling. Because many parts are inaccessible, especially the interior of the crater, the island's fauna is not threatened by hunting or habitat destruction.

Besides the plans for industrial development, which would destroy just the most unaltered places, the invasion of exotic species is causing concern. Red-vented Bulbuls have spread all over the island, but have apparently not caused the decline of native species. The invasion and dramatic increase of the Jungle Myna, however, will certainly affect those species which are either frugivorous (e.g. the Polynesian Starling and the Purple-crowned Fruit-dove) and/or nest in tree cavities (e.g. the Blue-crowned Lorikeet and the Polynesian Starling), as indicated by the decline of fruit-doves in plantation areas. A promising method of eradicating mynas on Pacific islands has yet to be found.

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SHORT NOTE

Spurwings retrieve their eggs

In late August - early September 1990, a pair of Spur-winged Plovers (*Vanellus miles novaehollandiae*) was nesting in an open paddock along with a big mob of ewes and lambs. Each morning as I passed the nest I checked the four eggs. One morning I saw that one of the eggs was about a metre from the nest. I decided to leave it there to see whether a predator would take it so near to the sitting bird. Next morning the egg was back in the nest. Two days later an egg was out of the nest again. I could see that lambs had been playing around the sitting bird; presumably they had frightened the bird off the nest, displacing the egg. Next morning the egg was back. A few days later two eggs had hatched and the next day all four had hatched.

On another occasion I saw a ewe lying very close to a sitting plover. I chased her away. Next morning she was lying beside the nest again. I had the impression she was 'mothering' the plover because this went on for several days. Twice I saw the ewe standing over the sitting bird and putting her head down as if to smell the bird. When I shifted the sheep to another paddock, the ewe made no effort to stay with the nest.

JACK LUTTRELL, *RD 1, Featherston*

On hearing this story from Mr Luttrell, during a weekend OSNZ camp near Matthews Lagoon, Wairarapa, Dr T.C. Dennison and I made a simple test at a nearby Spur-winged Plover nest. From the four-egg nest we moved an egg to about 30 cm away and watched from a car at close range. The bird returned to the nest, sat, and after about 3 minutes seemed to notice that an egg was missing. It looked around, saw the egg, walked to it, raked it back to the nest with its beak, and settled down again.

MALCOLM FALKNER, *40 Hennessey St, Foxton Beach*